LIVE FIRE TEST & EVALUATION

Live Fire Overview

The Live Fire Test and Evaluation (LFT&E) Program was enacted into law, Title X Section 2366, by Congress in FY86. The Federal Acquisition Streamlining Act of FY95 moved the program to the Office of the Director, Operational Test and Evaluation (DOT&E). The LFT&E program has, since its inception, required realistic survivability and lethality testing on platforms and weapons to assure that major systems perform as expected and that our combat forces are protected. The law has proven to be both enduring and flexible, permitting test realism to be balanced against cost and practicality.

Survivability and lethality testing conducted under the auspices of the LFT&E program generate information that directly supports the DOT&E mission of evaluating the effectiveness, suitability, and survivability of major defense acquisition programs. Under LFT&E, realistic lethality data is generated that, when combined with operational test and evaluation results, supports an assessment of operational effectiveness. Also under LFT&E, realistic platform (aircraft, ship, armored vehicle, *etc*.) vulnerability data, damage assessment and reparability information, and crew casualty information is generated and analyzed. This analysis, in conjunction with susceptibility data and operational test and evaluation results, support an evaluation of operational survivability.

LFT&E encompasses testing and evaluation over the course of a program, beginning with component-level testing during the initial design stage. Testing and evaluation continues as the system matures from assemblies to sub-systems, and finally to a full-up, system-level configuration. At the full-up, system-level, the weapon system is fully equipped for combat and with all sub-systems operational and powered. Early identification of deficiencies through LFT&E allows time to impact design trades and make design changes before production configurations are finalized thereby reducing costs.

INVESTMENT INITIATIVES

In support of its statutory requirements for system vulnerability and lethality testing and evaluation, the LFT&E office provides funding for initiatives that encompass similar and related efforts. These related efforts include increasing the coordination and integration of the testing and training communities, the testing and evaluation of fielded weapons and platforms, the production of munitions effectiveness manuals for the combatant commanders, and advancing technologies and methodologies to increase aircraft survivability.

LIVE FIRE TESTING AND TRAINING

The FY97 Defense Appropriation included congressional funding to investigate alternative uses of simulation and training technology in support of Live Fire Testing and Evaluation (LFT&E). This initiative came to be known as the Live Fire Testing and Training (LFT&T) program.

The LFT&T Program fosters the exchange of technology initiatives and uses between the live fire and test communities. The underlying LFT&T Program objectives are to enhance cost-effective testing and training and improve warfighting readiness. The program has funded twenty-five projects totaling approximately $28 million since its inception. Several projects have transitioned to operational use and are already providing benefits to the warfighter.

The LFT&T Program funded a total of nine projects in FY02. A summary of the FY02 projects follows:

- **Weapons Aimpoint Analysis and Training Tool:**
  Small arms weapons and their associated fire control systems are becoming increasingly more complex to enable engagement of targets that were previously considered protected or difficult to attack. The objective of this project is to develop an infrared live fire tracking and data collection system that will allow testing and training communities to measure, in real time, a gunner's aimpoint during target engagements and determine the true sources of error. New capabilities will include a method to validate ballistic models for

complex fire control systems, real-time gunner/weapon aimpoint position data, a method to separate gunner errors from weapon system errors, and enhanced weapon aimpoint and tracking feedback.

- **Man Portable Air Defense Systems Test and Training Results:** MANPADS shoulder fired missiles are a significant threat and of great importance to national and world security. The objectives of this project are to facilitate the collection and presentation of MANPADS test results to facilitate its use as training materials and in updating Joint Munitions Effectiveness Manuals and databases.

- **Moving Weapons Platform Simulator:** Operating a stabilized, platform mounted weapon is complicated and costly depending on platform and logistics costs, range availability, data collection time, and ammunition costs. These factors increase testing and training costs. The objectives of this project are to develop a system that allows weapons concepts to be evaluated earlier in the design process, reduce the live fire range time requirements, serve as an individual weapons operator training system, and serve as the baseline system for defining pilot/driver/weapons operator team training system requirements.

- **Virtual Target Gunnery System:** Using simulation technologies, targets used on live firing ranges can be greatly advanced beyond the technologies still in use from the 60's and 70's (*e.g.*, silhouettes, stationary or attached to a mechanical device/vehicle). This project will demonstrate an enhanced live fire target technology by presenting intelligent, simulated targets to trainees learning to use the Mark 38 25-mm machine gun. These simulated targets will be presented in a real world setting, with the targets integrated in real time into the gunner's real-world view.

- **Dismounted Infantryman Testbed:** Current simulation testbeds, focused at the individual/weapon level, do not provide the capability to examine the complex interrelationships and synergism of a fighting team employing multiple weapons. The objective of this project is to provide a validated multi-user training device that allows the testing and training communities to analyze, and subsequently optimize, the lethality and survivability of a fighting team. Specific objectives include: planning and conducting exercises on simulated test ranges to examine the interrelationships between man, team and multiple weapon systems employment, and developing performance metrics and analysis methodologies to support both the testing and training communities.

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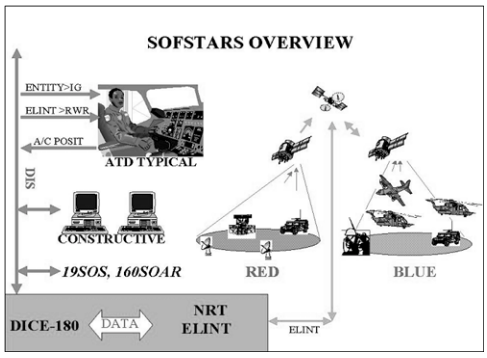
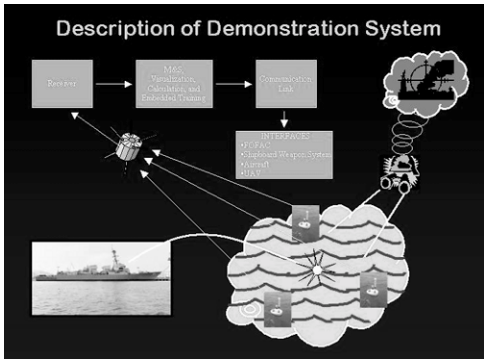
- **Live Fire Advanced Concepts:** Cost effective means to provide small unit training, development of tactics, techniques, and procedures, and testing of new weapons and warfighting concepts are needed. This project will create a simulated environment that allows soldiers to maneuver throughout the battlefield, using a head-mounted display to view the terrain and friendly and opposing forces. It is weapon system independent, and can easily accommodate the addition of new weapons.

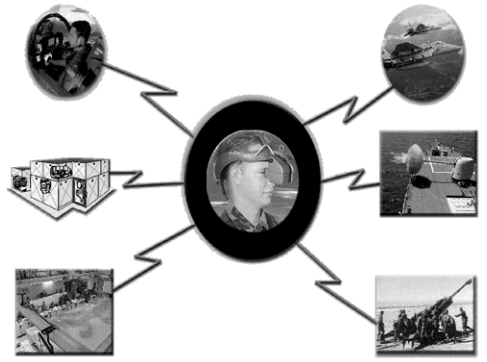
- **Special Operations Forces (SOF) Signals Training and Rehearsal System:** Special Operations Forces aircrew training devices do not provide for a realistic, simulated, combat environment because they do not include near-real-time intelligence information as would be encountered in the real world. The objective of this effort is to develop a system that will integrate live, virtual, and constructive simulations and national intelligence capabilities into SOF aircrew training devices.



- **Enhanced Overwater Scoring System:** The Navy had a need to perform end-to-end weapons testing and training without range space limitations, either in location or size. This project demonstrated a virtual, relocatable "range" for training, as well as for the test and evaluation of extended range weapon systems. This system allows land-based, sea-based, air-launched or dropped weapons to be fired at an impact area offshore over open water. The Navy has adopted this system for their live fire training activities.



- **Multi-Purpose Terminal Control and Supporting Arms Trainer:** Each of the services implements calls-for-fire in different ways, while joint operations require service members to interact with other service members with predictable results. This project will apply the latest display technologies, synthetic terrain viewers, and scenario development techniques to the development of a prototype multi-purpose terminal control and supporting arms trainer (MultiSAT). The MultiSAT will provide a joint standardized system for instruction in the employment and techniques of Naval surface fire, tactical air, and field artillery support in expeditionary operations.



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JOINT LIVE FIRE PROGRAM

The Joint Live Fire (JLF) Program was initiated by the Office of the Secretary of Defense (OSD) in March of 1984 to establish a formal process to test and evaluate fielded U.S. systems against realistic threats. This process continues today taking into account changes in operational scenarios, changes in threat munitions and targets, and the testing of legacy systems. This process provides a means to gather additional data not collected by acquisition programs. It allows survivability and lethality assessments of fielded systems or for specific component upgrade programs where LFT&E does not encompass the overall system. DOT&E/LFT provides funding and technical and financial oversight.

The JLF program consists of three groups: Aircraft Systems (JLF/AS), Armor/Anti-Armor (JLF/A/AA), and Sea Systems (JLF/SS). JLF/AS focuses on the vulnerability of U.S. fixed-wing and rotary aircraft to realistic threats and on the lethality of fielded U.S. weapons/munitions against foreign aircraft. The JLF/A/AA focuses on the vulnerability of fielded U.S. ground systems (tanks, trucks, armored personnel carriers) to realistic threats and on the lethality of fielded U.S. weapons/munitions against realistic targets. The JLF/SS focuses on the vulnerability of fielded surface combatants, including attack gunboats, and on the lethality of fielded U.S. weapons/munitions against realistic targets.

In FY02, the JLF/AS program addressed the vulnerability of the CH-47 Chinook, C-130 Hercules, H-60 Blackhawk, and the lethality of the U.S. 20mm projectile PGU-28/B against selected foreign targets. In addition, FY02 efforts included continued development of Man-Portable Air Defense Systems test capability to increase the amount of information gained from each shot.

- **CH-47D Testing and Analysis:** The CH-47D Chinook helicopter JLF program includes tests and analyses to determine the vulnerability of the rotor blade and the rotor power train to expected threat projectiles. The Army Research Laboratory and the Boeing Company jointly completed integrated ballistic and structural tests. Test planning and damage prediction analyses were also completed for the final rotor blade test series (dynamic, loaded rotors on a CH-47D ground-test helicopter) to occur in FY03. Test equipment/target material buildup and pre-shot predictions were completed in preparation for the first phase of rotor power train (transmission) gunfire tests scheduled early in FY03.

- **Transport Aircraft Vulnerability Testing and Analysis:** A dynamic, free-flight test of a MANPADS missile against a C-130 aircraft with a running engine was conducted to determine the vulnerability of a pylon-mounted, turbo-fan engine and associated secondary effects to the platform from this threat. All damage modes were documented and used in furthering the state of the art in modeling and simulation. This test also provided an opportunity for Air Force C-130 Battle Damage Repair technicians and engineers to gain practical experience on a C-130 with realistic MANPADS damage. Additionally, JLF is conducting an analysis to determine the types of damage that will result in a C-130 mission abort and the vulnerable area of the aircraft for those types of damage. In upgraded C-130 configurations, some functions performed by the crew in older models have been automated and the crew size reduced.

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- **PGU-28/B Lethality Testing:** The U.S. 20mm PGU-28/B SAPHEI (semi armor-piercing high explosive incendiary) projectile was developed in the mid 1980s, replacing the U.S. M-56A3 HEI projectile in the air-to-ground role due to its armor penetrating capability. Two separate, but complimentary, test programs were conducted to better understand the lethality of the PGU-28/B against a MIG-29 Fulcrum and a MIL-24 Hind. Information was collected and analyzed to characterize the lethality of this munition against these targets and to provide information to the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME). Data provided to the JTCG/ME assisted in characterizing the effectiveness of the PGU-28/B against several threat systems and for updating the Joint Munition Effectiveness manuals.

- **H-60 Testing:** The H-60 helicopter program includes tests and analyses to determine the ballistic vulnerability of the tail rotor subsystem. This effort complements the ongoing Joint Army/Navy H-60 Helicopter LFT&E program, since the tail rotor subsystem is common to the Army's UH-60M and the Navy's MH-60S and MH-60R aircraft. Battle Damage Assessment and Repair (BDAR) efforts will be coordinated with the Army Aviation Logistics School at Fort Eustis, Virginia.

In FY02, the JLF/A/AA program continued to evaluate, through ballistic testing, the lethality of selected U.S. munitions against a foreign main battle tank and against the Scud-B system. JLF/A/AA also investigated the fire and explosion suppression capabilities of fuel tank filler technologies.

- **Munitions Lethality:** Lethality testing was continued against a classified foreign main battle tank target. These tests were started in FY01 and will conclude in FY03. The objectives of these tests are to assess the lethality of current and developmental U.S. munitions against a currently fielded, foreign main battle tank, to acquire empirical data to calibrate current vulnerability methodologies, to update existing JLF and LFT&E databases, to supplement live-fire lethality tests and evaluations for the tested munitions, and to provide empirical data to assist field commanders in training on how to engage and defeat the tested threat target. The results will be incorporated in the JTCG/ME munitions effectiveness manuals.

- **Munitions Lethality: SCUD-B Target:** Lethality testing of several U.S. munitions against the Scud-B target continued. These lethality data will be used by the JTCG/ME to update joint munitions effectiveness manuals. Additionally, planning was completed for the conduct of testing against a chemical warhead surrogate to determine the potential for destroying chemical warheads and the potential hazard posed by release of warhead contents.

- **JLF Fuel Tank Filler Tests:** Fuel cells in ground and air vehicles contribute to a significant portion of the system's vulnerable area. Threat munitions impacting and penetrating or perforating these cells can lead to fuel fire explosions and/or sustained fuel fires which could possibly lead to the catastrophic destruction of the targeted system. Fuel cell inerting technologies have been developed which effectively suppress explosions in impacted fuel cells. A series of tests were conducted to determine the ullage suppression performance of selected fuel tank filler technologies.

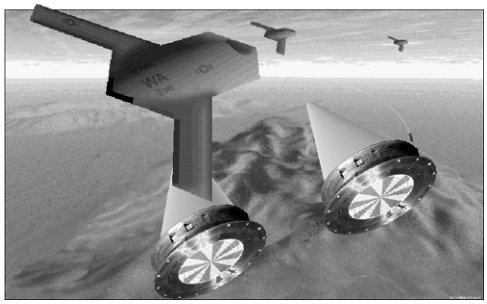
In FY02, the JLF/SS program conducted a series of lethality tests against an aluminum hulled Mk3 Patrol Boat for the purpose of demonstrating HELLFIRE Missile lethality against small boat threats. Two tests were conducted by dynamically firing a shaped charge variant of the HELLFIRE on a sled-track. A third shot was a static detonation of the blast and fragment variation of the missile. Data and damage assessment collected and analyzed will be used by the JTCG/ME to address a systems effectiveness requirement.

JOINT TECHNICAL COORDINATING GROUP ON AIRCRAFT SURVIVABILITY

The Joint Technical Coordinating Group on Aircraft Survivability (JTCG/AS) was chartered in 1971 by the Joint Logistics Commanders to provide a mechanism to ensure inter-service exchange of aircraft survivability technologies, modeling and simulation (M&S) methodologies, and design tools necessary to field more survivable and combat effective aircraft. The JTCG/AS was re-chartered in 1991 under the Joint Aeronautical Commanders Group and has since focused on establishing survivability as a design discipline, developing vulnerability and susceptibility reduction technologies, providing standard models to assess aircraft survivability, and supporting survivability education.

In FY02, the JTCG/AS worked closely with members of the acquisition community and DOT&E to identify critical issues regarding aircraft survivability. In response, the JTCG/AS funded almost 50 projects worth approximately $8.4 million to enhance aircraft survivability in areas such as fire and explosion protection, reduction of susceptibility and vulnerability to MANPADS, advanced threat identification and exploitation, advanced electronic warfare technology, and aircraft survivability model development and upgrades. Several examples of these projects are shown below.

- **Weapons Bay Ablative "Proof of Concept":** This project was developed to reduce the vulnerability of combat aircraft from a ballistically impacted munition and to obtain critical protection data on a full-scale weapons bay. This project has increasing importance for advanced low-signature aircraft that carry weapons internally. The JTCG/AS is working closely with Lockheed Martin and government engineers to use this data in the design of the F-35 aircraft.



- **Very Wideband Accurate Direction Finding (DF):** This project will enable improved aircrew situational awareness and thus improved platform survivability. It provides airborne antenna apertures that allow 360-degree reception, ambiguity resolution, and accurate location of threat signals, which do not currently exist in most combat aircraft today. This project is intended to both enhance capabilities and miniaturize electronic warning and threat identification systems for transition to future platforms such as UAVs.

- **Survivable Engine Control Algorithm Demonstration (SECAD):** This project along with the Engine Damage Detection program will reduce aircraft propulsion system vulnerability to engine damage in combat (ballistic impact) and peacetime (foreign object damage, bird ingestion) by preserving thrust and engine operating stability. During combat, this capability could allow the aircrew additional engine operating time to safely egress from hostile areas or return safely to allied bases. The SECAD program designed an algorithm capable of detecting and classifying engine damage by using only existing engine sensors as input parameters. The algorithms use the existing aircraft FADEC (Fully Automated Digital Engine Control) to detect damage and then adjust engine operating schedules allowing the engine to continue operating at less than optimum levels. The development is currently being conducted in coordination with the F-18 program office and General Electric. The SECAD improvements have been incorporated into the F/A-18E/F developmental roadmap.

- Under survivability model initiatives, several projects provide configuration management and user support for a core set of models as newer models are being developed by the services and industry. The JTCG/AS funds projects to track baseline codes, updates to those codes, user forums to exchange information and lessons learned about these models and their applications. Additionally, the JTCG/AS sponsors the Joint Accreditation Support Activity (JASA), which documents the credibility of these survivability models.

- The Integrated Survivability Assessment (ISA) project will develop a process, integrating the proper roles of modeling and simulation with test and evaluation, to evaluate the overall integrated operational survivability of an aircraft system. This process combines engineering level data, Live Fire test data, and mission level M&S data with operational test results to determine the platform operational survivability.

JOINT TECHNICAL COORDINATING GROUP FOR MUNITIONS EFFECTIVENESS

The joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) was chartered by the Joint Logistics Commanders (JLC) over 30 years ago to serve as DoD's focal point for authenticated non-nuclear munitions effectiveness information. The JTCG/ME, under the auspices of the JLC's, authenticates data/methodology for use in training, systems acquisition, weaponeering, procurement, and combat modeling. Joint Munitions Effectiveness Manuals (JMEMs) are used by the Armed Forces of the United States, NATO, and other allies to plan operational missions, support training and tactics development, and support force-level analyses. The JTCG/ME also develops and standardizes methodologies for the evaluation of munitions effectiveness and maintains databases for target vulnerability, munitions lethality and weapon system accuracy.

JTCG/ME

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In FY02, the JTCG/ME executed the following work program:

- Enhanced the operational tools and data on the following JMEM CD-ROMs: JMEM Air-to-Surface Weaponeering System (JAWS) v2.2. Attack (in support of Operation Enduring Freedom), v2.2.1, and v2.2.2; Joint Anti-Air Combat Effectiveness – Air Defense (J-ACE: AD) v2.0; Joint Anti-Air Combat Effectiveness - Air Superiority (J-ACE: AS) v2.1; Joint Anti-Air Combat Effectiveness - Ship Anti-Air Warfare (J-ACE: AAW); JMEM/Surface-to-Surface Weaponeering Effectiveness System (JWES) v2.0, v2.1 and Target Manual v2.3 on JAWS.

- Increased support to the warfighter, by distributing products and product updates via the classified Internet with the JTCG/ME Products and Information Access System (JPIAS).

- In response to high priority requirements, continued population of existing databases to incorporate weapons effectiveness and target vulnerability data.

- Continued execution and technical coordination efforts to address target vulnerability data generation.

- Continued the development of standardized models and methodology for Air-to-Surface, Surface-to-Surface and Anti-Air effectiveness calculations.

- Conducted Configuration Management/VV&A efforts on specific JTCG/ME models.

- Together with the JTCG/AS, released Advanced Joint Effectiveness Model (AJEM) v2.0, conducted AJEM Production Analysis Support and released Component Vulnerability Analysis Archive v5.0.

- In coordination with J-8, developed Chairman, Joint Chiefs of Staff Instruction to codify the command requirements data call and prioritization in support of FY03 program build.

- Initiated intelligence collection/production requirements process in collaboration with the Defense Intelligence Agency and Service intelligence centers.

- Continued to implement National Disclosure Policy and classification review of JMEM CD-ROMs to address requirements for coalition operations.